to be protected against both narrow-band continuous and tropospheric interference. Those values are included in section 4.1.1.11.1 of the Draft Report of the CPM to WRC-97.

However, the values for maximum interfering power flux determined by WP 8D and carried over into the Draft CPM report, assumed that the interfering narrow-band MSS signals could be in the most sensitive portions of an AM/VSB analogue TV signal, that is, in and around the visual carrier. In that region, a protection ratio (PR) of 58 dB would be required against continuous interference, and of 50 dB against tropospheric interference.

Furthermore, neither the WP 8D document nor the Draft CPM report discusses the question of whether the intermittent, irregular, and brief nature of the narrow-band MSS signals would mean that they could be likened to tropospheric interference against which a PR of 50 dB (rather than 58 dB) would be required.

Section 3 of this contribution discusses the lower PR that would be required in less sensitive portions of AM/VSB signals.

Section 4 discusses the PRs that would be required for protection of Digital Television.

Section 5 discusses the protection of auxiliary signals that may be used in broadcasting bands for the transmission of data.

Conclusions on the feasibility of sharing are given in Section 6.

3.0 Permissible Interfering Power Flux for AM/VSB and Digital TV Signals

Extracts of Tables 4.1 and 4.2 of the Draft Report of the CPM to WRC-97, supplemented by information from Rec. ITU-R is.851-1, are shown in Table 1.

The highest level of permissible interfering power flux to AM/VSB systems shown in Table 1 is -137.8 dBW/m^2 at 800 MHz. However, TDMA/FDMA non-GSO MSS systems will need to produce levels of from -122 to -127 dBW/m^2 at the surface of the earth to provide a useful service to small, inexpensive terminals. Since power flux limits are established based on the protection requirements of the potentially interfered-with service, rather than the service requirements of the potentially interfering service, some factors or techniques would have to be found to permit an increase in the permissible level of potentially interfering signals.

Note that the levels for maximum permissible interference are given in power per unit area, that is, as power flux, and not as power flux density, the measure of which is power per unit area in a reference bandwidth (typically 4 kHz or 1 MHz). Therefore, the total power of an interfering signal anywhere within the bandwidth of a TV channel (6, 7, or 8 MHz, depending on the TV transmission standard employed) would be limited to that value, regardless of its bandwidth or power flux density.

It will be incumbent on operators of MSS systems to insure that the total interference power from one or more satellites or systems sharing the broadcasting bands does not exceed the power flux limit in any TV channel at any instant, and over any period of time. It is technically and operationally feasible to insure that the maximum permissible power flux limit is never exceeded through coordination among MSS system operators.

Table 1
Maximum Power Flux for Narrow Band Non-GSO MSS in Television Broadcasting Bands
<u>Transmitting in the Most Sensitive Portion of the Spectrum of a TV Signal</u>

Frequency (Note 1)	Analogue Television						Digital
	216 MHz				800 MHz		216 MHz
Type of Interference	Continuous Grade 4 Impairment		Tropospheric Occasional Grade 3 Impairment		Continouous Grade 4 Impairment	Tropospheric Occasional Grade 3 Impairment	
Area	high-noise	low-noise	high-noise	low-noise			
Protection ratio (dB)	58	58	50	50	58	50	20
Minimum field strength to be protected (Note 2) [dB(μV/m)]	49	43	49	43	58	58	41.5 (Note 3)
Maximum interfering power-flux [dB(W/m²)]	-154.8	-160.8	-146.8	-152.8	-145.8	-137.8	-124.3

NOTES:

1. The Draft CPM Report uses the individual frequencies shown here. However, from Rec. ITU-R is.851 it is clear that the values for 216 MHz apply equally to the frequency range 162-230 MHz (Band III), and the values for 800 MHz apply equally to the frequency range 582-960 MHz (Band V).
The permissible power flux for Band IV, 470-582 MHz, can be derived from Rec. ITU-R is.851-1 and Tables 4.1 and 4.2 of the Draft CPM Report: for continuous interference and a PR of 58 dB: -150.8 dB(W/m²); and for intermittent/tropospheric interference and a PR of 50 dB: -142.8 dB(W/m²).

2. At the edge of coverage area 50% of time and 90% of locations. The minimum field strength to be protected at the edge of coverage 50% of time and 50% of locations is 6 dB higher [55 dB(μV/m)] in the band 162-230 MHz: 12 dB higher [65 dB(μV/m)] in the band 470-582 MHz; and 12 dB higher [70 dB(μV/m²] in the band 582-960 MHz.

3. Derived equivalent minimum field strength

3.1 Factors and techniques that would permit higher levels of permissible interfering power flux

Figures 1, 2, and 3 of Rec. ITU-R.851-1, show the PRs against continuous and tropospheric interference, 58 dB and 50 dB, respectively, that would be required in those portions of the TV signal most sensitive to interference. However, required PRs elsewhere in the TV signal spectrum can be considerably lower.

For example, for 525-line M/NTSC and M/PAL systems the required PR against tropospheric interference approaches zero in the vestigial lower sideband. Above the aural sound carrier, a PR of about 15 would be adequate. For continuous interference, the PR in the lower vestigial sideband would still approach zero, while the PR above the aural carrier would be about 25 dB.

For 625-line systems, the PR against tropospheric interference in the lower sideband approaches 32 dB for SECAM systems H, I, K1, and L and approaches 23 dB for PAL systems B, D, G, and K. At the upper end of the TV channel, the PR decreases to about 25 dB for all PAL and SECAM systems. For continuous interference, the PR in the lower vestigial sideband near the band edge decreases to 40 dB for SECAM systems H, I, K1 and L, and to 32 for PAL systems B, D, G, and K. At the upper band edge, the PR decreases to 35 dB for all PAL systems, and to 30 dB for all SECAM systems.

Another factor which aids in reducing the effect of interfering signals at frequencies of the lower vestigial sideband, especially those signals near the lower band edge, is the presence of a Nyquist filter in all TV receivers regardless of TV standard. Such filters introduce some 17 dB of discrimination against signals in that part of the TV spectrum.

3.2 The intermittent nature of non-GSO MSS (space-to-Earth) transmissions

It is clear from Recs. ITU-R BT.655-4 and is.851-1 that the sole distinguishing factor between "continuous" and "tropospheric" interference is the non-continuous, or intermittent nature of tropospherically propagated interfering signals.

For example, consider Section 2.1 of Rec. ITU-R is.851-1:

> The [protection] ratios applied to tropospheric interference correspond closely to a slightly annoying impairment condition (Grade 3). They are considered

acceptable only if the interference occurs for a small percentage of time, not precisely defined but generally considered to be between 1% and 10%. for substantially non-fading unwanted signals, it is necessary to provide a higher degree of protection. In this case, the protection ratios appropriate to continuous interference, which corresponds closely to perceptible but not annoying (Grade 4) should be used.

It is equally clear from Section 3, "Protection Margin for Television Services," that the only difference between continuous and tropospheric interference is the percentage of time during which the interference is present. The formula for the protection margin against continuous interference is given as:

$$E_C = E_{(50,50)} + P + A_C$$

and the formula for the protection margin against tropospheric interference is given as:

$$E_T = E_{(50,t)} + P + A_T$$

The only substantive difference between the two formulas is the percentage of time during which the signal from the interfering source is present.

Emissions from non-GSO MSS satellites will be used to send short messages to earth terminals in the system[2] The digital, GMSK interrogating signals will be brief (on the order of 400-500 ms), narrow-band (15 kHz) intermittent (being present no more than 10% of the time), and both widely spaced and aperiodic. In other words, the maximum total of 10% of the time will be made up of short, irregular, infrequent digital pulses which will not be coherent with line, frame, or field frequencies of the TV picture.

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[2]Some space-to-Earth transmissions will be used to send messages and data in digital form to earth terminals, making such messages longer and more continuous than the typical interrogation signals. Any such transmissions that are longer or more frequent than those would be deemed "intermittent" as discussed above, would be governed by the higher PR applicable to "continuous" interference and the consequential lower permissible levels of power flux.

Interfering signals propagated tropospherically above the surface of the earth typically have a median value about which the signals fluctuate, both above and below the median, as well as occasional fades as deep as 10, 20 or even more dBs. On the other hand, space-to-Earth transmissions from non-GSO MSS satellites reach the surface of the earth in line-of-sight paths which are relatively unaffected by tropospheric effects over a wide range of angles of arrival. Therefore, their signal level will be relatively constant when present, and completely absent between transmissions of the brief signals. As such, these signals will be even more intermittent than "intermittent" tropospheric signals.

3.3 The feasibility of utilizing the less sensitive portions of the TV signal spectrum

The typical footprint of proposed non-GSO, MSS systems is on the order of 5,000 km Therefore, a satellite space-to-Earth signal can be placed in the same less sensitive portion of terrestrial TV channels at a particular moment in time only in two circumstances: the first is when all the terrestrial TV transmitters located within the moving footprint at that instant use the same channelizing plan. The second is when the less sensitive portions of different TV channels coincide. For example, when the less sensitive portion of every fifth channel in one channel plan coincides with the less sensitive portion of every sixth channel in another plan within the footprint.

The frequencies of individual television channels are uniform throughout Region 2. A different, but uniform channel plan is in effect throughout Region 1 as the result of the European and African Broadcasting Conferences of 1961 and 1963. Thus, narrow-band MSS signals could be placed on frequencies in the less sensitive parts of TV channels throughout the Western Hemisphere, and on different frequencies throughout Europe and Africa.

There are even several common frequencies that exist between the plans of Regions 1 and 2.

Some administrations in Region 3 adhere in whole or in part to the channel plans for Regions 1 or Region 2. For example, TV channels in Japan have the same band limits as those in Region 2, while the band limits of some Chinese, Australian and Singaporean TV channels are the same as some of those in the plan of Region 1. The consequence is that frequencies might be found for narrow-band emissions that would place them in the less sensitive portions of TV channels within the satellite footprint at each instant of time as that footprint passes over administrations in Region 3. If one or more frequencies cannot be found that would permit the space-to-Earth MSS transmission to be located in the less sensitive portions of all active TV channels within the satellite footprint as it traverses Region 3, then the PR of 50 dB, and the commensurately lower power flux limit necessary to provide that protection, would govern satellite transmissions. In any event, Article S9.11A (formerly Res. 46) would have to be amended to include power flux levels for sharing between MSS space-to-Earth and the broadcasting service.

4.0 Protection Ratios for Digital Signals

The protection ratio of 20 dB shown in Table 1 for continuous interference into a digital TV signal reflects the less sensitive nature of digital modulation. However, since the spectrum of digital TV signals is essentially flat, no portion of the spectrum is any less sensitive than any other. The higher power flux associated with this PR is -124.3 dB(W/m^2).

However, since the required PRs for AM/VSB TV systems are significantly higher, and the associated power flux limits commensurately lower, it will be those values which will limit the interference power of MSS space-to-Earth transmissions until some future time when digital TV transmission has replaced analogue transmission.

5.0 Protection of auxiliary signals

In the United States, two auxiliary data signals have been developed and are permitted. One, "Digideck," would be placed in the vestigial sideband. Its 3 dB passband runs between 825 kHz and 1,250 kHz below the visual carrier. That would place it between 50 kHz and 425 kHz above the lower band edge of an NTSC channel. The power of a Digideck signal is planned to be 30 dB below the peak visual carrier (including sync). Taking into account the 17 dB attenuation of the receiver's Nyquist filter, that implies a TV signal to Digideck interference ratio of 47 dB.

A 15 kHz narrow-band non-GSO MSS signal could be placed in the unused 50 kHz band segment immediately below the Digideck signal. Taking into account the maximum MSS Doppler shift of ± 17 kHz at 800 MHz there would still be adequate separation between the MSS and the Digideck signals to prevent interference between them.

The other auxiliary data signal that has been proposed is "Wavephore." This data signal overlaps the video spectrum and becomes an inherent part of the video information. The data, on a carrier of 4.197 MHz, is combined with the composite video signal prior to modulating with the picture carrier, or, at the baseband level. This signal appears in that portion of the TV signal spectrum that would not be considered for narrow-band MSS transmissions because it is a region of high PR requirements.

6.0 Conclusions

Table 1 and its notes show that the maximum permissible power flux in Bands III, IV, and V (162-230 MHz, 470-582 MHz and 582-960 MHz, respectively) from a continuous interfering MSS signal would be: -160 dB (W/m^2), -150.8 dB(W/m^2), and -145.8 dB(W/m^2), respectively. The table also shows that the power flux from an intermittent interfering MSS signal could be eight dB higher: - 152.8 dB(W/m^2), -142.8 dB(W/m^2), and -137 dB(W/m^2), in each of the three frequency bands, respectively.

If a narrow-band space-to-Earth transmission from a non-GSO MSS, meeting the criteria described above for intermittency, is placed in the least sensitive portion of all active AM/VSB channels within its antenna footprint, a protection ratio of 32 dB would still provide the protection required by all 525- and 625-line AM/VSB systems[3]. This limiting PR, 32 dB is still well above the protection ratio of 20 dB required by digital TV systems.

The power flux limits that would provide a PR of 32 dB in the least sensitive portion of any TV signal are given in Table 2 for Continuous and Tropospheric (i.e. Intermittent) MSS signals, that is, for signals present more or less than 10% of the time. The power flux levels shown for intermittent non-GSO MSS interference are -134 dB(W/m^2), -124 dB(W/m^2), and -119.8 dB(W/m^2) for the three bands, respectively.

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[3]The controlling factor is the PR of 32 dB required by the H, I, K1, and L systems in the least sensitive portion of their spectra near the lower edge of the TV channel.

Table 2

Maximum Power Flux for Narrow-Band Non-GSO MSS in Television Broadcasting Bands for Continuous (≥10%) and Tropospheric (≤10%) Interference

<u>Transmitting in the least sensitive portion of the spectrum of any active TV channel</u>

Frequency	Band III 162-230 MHz		Band IV 470-582 MHz		Band V 582-960 MHz	
MSS Interference	Continuous ≥10%	Intermittent ≤10%	Continuous ≥10%	Intermittent ≤10%	Continuous ≥10%	Intermittent ≤10%
Governing Protection Ratio	40	32	40	32	40	32
Maximum Interfering Power-flux [dB(W/m^2)]	-142.8	-134.8	-132.8	-124.8	-127.8	-119.8

CERTIFICATE OF SERVICE

I, Jacquelyne White, hereby certify that on this 15th day of September, 1997, I caused copies of the foregoing **Comments of Final Analysis Inc.** to be served on the parties listed below via first-class mail, postage prepaid. Those parties marked by an asterisk were served via hand delivery.

The Honorable John Bryant
Chairman, U.S. Delegation to WRC-97
U.S. Department of State
EB/CIP
Washington, D.C. 20520

Thomas S. Tycz*
Federal Communications Commission
International Bureau
2000 M Street, N.W., Room 811
Washington, D.C. 20554

Warren Richards
U.S. Department of State
2201 C Street, N.W., Room 2529
Washington, D.C. 20520

Cecily C. Holiday*
Federal Communications Commission
International Bureau
2000 M Street, N.W., Room 520
Washington, D.C. 20554

Sean White*
Federal Communications Commission
Office of Engineering & Technology
2000 M Street, N.W., Room 427
Washington, D.C. 20554

Harold Ng*
Federal Communications Commission
International Bureau
2000 M Street, N.W., Room 512
Washington, D.C. 20554

Chairman Reed E. Hundt*
Federal Communications Commission
1919 M Street, N.W., Room 814
Washington, D.C. 20554

Maureen McLaughlin*
Federal Communications Commission
Wireless Telecommunications Bureau
2025 M Street, N.W., Room 7130
Washington, D.C. 20554

Commissioner James H. Quello*
Federal Communications Commission
1919 M Street, N.W., Room 802
Washington, D.C. 20554

Commissioner Rachelle B. Chong*
Federal Communications Commission
1919 M Street, N.W., Room 844
Washington, D.C. 20554

Commissioner Susan Ness*
Federal Communications Commission
1919 M Street, N.W., Room 832
Washington, D.C. 20554

Julie Garcia*
Federal Communications Commission
International Bureau
2000 M Street, N.W., Room 506
Washington, D.C. 20554

Damon C. Ladson*
Federal Communications Commission
International Bureau
2000 M Street, N.W., Room 803
Washington, D.C. 20554

Cassandra Thomas*
Federal Communications Commission
International Bureau
2000 M Street, N.W., Room 810
Washington, D.C. 20554

Peter Cowhey*
Chief, International Bureau
Federal Communications Commission
2000 M Street, N.W., Room 800
Washington, D.C. 20554

Ruth Milkman*
Federal Communications Commission
International Bureau
2000 M Street, N.W., Room 821
Washington, D.C. 20554

Jacquelyne White

Jacquelyne White